

Pavement Life Cycle Assessment Workshop, May 5–7, 2010 in Davis, California, USA

John Harvey · Alissa Kendall · Nick Santero ·
Thomas Van Dam · In-Sung Lee · Ting Wang

Received: 21 June 2011 / Accepted: 25 August 2011 / Published online: 8 September 2011
© Springer-Verlag 2011

Abstract

Purpose A workshop was convened on life cycle assessment (LCA) applied to pavement. The workshop's primary goals were to establish common practices for conducting LCAs for pavements. In general, pavement LCA has been implemented without clear guidelines for modeling assumptions and reporting. This shortcoming has led to challenges in interpreting and comparing pavement LCA outcomes.

Methods A 2-day workshop was convened with 45 participants from academia, US and foreign transportation agencies, and industry. The workshop yielded some agreement and dissent on proposed guidelines for implementing and reporting of pavement LCA. Discourse on particular topics was facilitated through break-out sessions tailored to the workshop attendees and their respective areas of expertise.

Results and conclusions Consensus was not reached for all issues discussed at the workshop. Where consensus did not emerge, dissenting views were recorded and included in workshop reporting. However, the majority of topics did resolve with consensus and informed the development and revision of a publicly available framework and guideline for pavement LCA. This framework and guideline was available at the conference website (<http://www.ucprc.ucdavis.edu/P-LCA/index.html>) and remains available for continued comment.

Keywords Asphalt · Highway · LCA · Pavement · Roadway

J. Harvey · I.-S. Lee · T. Wang
Pavement Research Center, University of California,
3327 Apiary Road,
Davis, CA 95616, USA

J. Harvey · A. Kendall (✉) · I.-S. Lee · T. Wang
Department of Civil and Environmental Engineering,
University of California,
Davis, One Shields Ave.,
Davis, CA 95616, USA
e-mail: amkendall@ucdavis.edu

N. Santero
Department of Civil and Environmental Engineering,
University of California,
407 McLaughlin Hall,
Berkeley, CA 94720-1712, USA

T. Van Dam
Applied Pavement Technology Inc.,
200 Michigan St., Suite 321,
Hancock, MI 49931, USA

1 Background and introduction

On May 5–7, 2010, the University of California Pavement Research Center (UC-PRC), Davis, CA (USA) hosted a Pavement Life Cycle Assessment Workshop. Forty-five invited participants from academia (18); local, state, and federal US agencies (12); industry (eight); non-US transportation agencies (four); and LCA consulting firms (three) attended. A full list of participants is available at <http://www.ucprc.ucdavis.edu/P-LCA/participants.html>.

The workshop's primary goals were to establish common practices for conducting life cycle assessments (LCAs) for pavements. Four practices or issues related to LCA applied to pavements were developed and discussed during the workshop: (1) an LCA framework for pavements; (2) a summary of system boundaries and assumptions for the framework, as well as an examination of the benefits and drawbacks of alternative boundaries and assumptions; (3) assessment of models and data for each phase of the life cycle based on pavement project type; and (4) documentation require-

ments for pavement LCAs to facilitate comparison between studies in terms of scope, system boundaries, assumptions, life cycle inventory data, and models.

The workshop organizers selected these topics of discussion because of the large number of pavement LCAs which use incommensurate system boundaries, scopes, and assumptions, while also providing insufficient detail and transparency for interpretation, comparison, and meta-analysis. Discussion was held in break-out groups developed by the organizers. Break-out group participant selection ensured that experts in relevant fields were combined to stimulate sophisticated and animated dialogue that included dissenting views. Each discussion group was also provided a recorder and a facilitator.

The goal of the workshop's discussions was a set of three deliverables: (1) a record of workshop discussions critiquing documents prepared for the four topics described above, (2) identification and discussion by workshop participants of critical gaps in knowledge or conflicting practices in pavement LCA, and (3) areas of consensus and dissent among workshop participants and documentation of alternative views. These three deliverables were then used to update the proposed pavement LCA framework, which was then online for critique and review from a broader audience.

2 Workshop process and key findings

The first morning invited speakers and the organizers presented background information on LCA and highlighted current practices in pavement LCA. At the end of day 1, the organizers together with workshop participants developed a set of topics to be addressed in break-out sessions on day 2, and workshop participants were able to record their preferences for break-out session groups.

On the second day of the workshop participants spent most of the day in their break-out groups discussing assigned topics. Each group prepared brief summaries of their findings for each research question. Below are the topics discussed by groups, and a summary of their findings. Most questions were assigned to multiple groups to capture a greater breadth of views.

Topic: Critique of the framework developed by the workshop organizers.

- A general agreement on the overall proposed structure, but the need for a greater focus on the goal of an LCA.
- No consensus among participants for a consistent definition of the appropriate functional unit for pavement LCA.

- The proposed framework applies to project-level assessments, which should be distinguished from network-level assessments.

Topic: Bitumen feedstock energy in LCA and how it should be interpreted.

- Reporting of feedstock energy should occur to be compliant with ISO standards; however, it should clearly be differentiated from other energy use.
- Net upgrading impacts could be calculated for possible inclusion in LCA, reflecting the burdens required to upgrade bitumen to fuel grade products.

Topic: Pavement surface characteristics and vehicle rolling resistance: do we have the right models and methods to include this in an LCA?

- The use phase effects of pavements on vehicles should be included; however, we still need to identify improved, mechanistic models to model this process with greater certainty.
- Transportation agencies in particular see a risk that this modeling would add too much uncertainty and complexity to pavement LCA.

Topic: Incorporating LCA into multi-criteria decision-making for asset management.

- A diversity of opinions among break-out groups. However, there was some agreement regarding the opportunity to use multi-criteria decision-making to add LCA to pavement management systems which currently use life cycle costs for decision-making.

Topic: How should analytical time horizon should be selected for a pavement LCA, particularly in a comparative study where designs may have dissimilar but long life times?

- There was no conclusive finding on the appropriate analysis period; however, discussion on the definition of a pavement service life yielded some consensus
- There was a consensus opinion that the defined pavement service life should include demolition activities for the major rehabilitation occurring at the end of the service life. There were dissenting views on whether rehabilitation should be included in the definition of a service life.

Topic: What are the preferred recycling allocation and material "down-cycling" methods?

- Dissenting views among break-out groups. The only consensus view was that the 50/50 allocation or any arbitrary allocation approach is not defensible.

Topic: How and when should heat island effect be taken into account in pavement LCA?

- Dissenting views on the scalability of the heat island effect down to the scope of a pavement system LCA. However, at least one group reached consensus that the heat island effect was important to include, and that current models could be scaled to meet the scope of a pavement LCA.

Topic: What are the questions faced by policy-makers and what outcomes from LCA are necessary to answer these questions? How would agencies implement LCA, and what is the difference between design-build and design-bid-build in agency decision-making?

- Integration with pavement management system is important. Agencies want win–win answers, where cost and environmental performance are in sync.
- Agencies and LCA practitioners are wary of making a “LEED point-counting” process which could result in mistakes or perverse outcomes.¹

3 Post-workshop development of the pavement LCA framework

The UC-PRC research team, along with partners at University of California, Berkeley, has continued to refine the pavement LCA guideline and framework based on outcomes from the workshop and continued feedback from workshop participants. A revised guideline and framework were posted on the Pavement Workshop website for continued critique and feedback in an effort to make the process as transparent and open as possible, and to support continuous improvement. These documents and links for providing feedback are available at <http://www.ucprc.ucdavis.edu/p-lca/resources.html>.

The website provides open access and to all pavement LCA practitioners, users, and decision-makers who have a stake in understanding pavement LCA and contributing to its improvements. The framework and guidelines have also yielded a checklist for practitioners to encourage transparent LCA reporting that can be downloaded at <http://www.ucprc.ucdavis.edu/p-lca/resources.html>.

¹ LEED refers to *Leadership in Energy and Environmental Design*; it is a green building rating system and certification program from the U. S. Green Building Council. The rating system and certification program has gained widespread popularity in the U.S. and more recently is gaining popularity internationally. The rating and certification system has recently been revised, but earlier versions received critique for their point-counting surveys and methods.